Teaching Challenges and Educators' Perceptions on STEM Implementation in Schools in Punjab, Pakistan

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Introduction

STEM education has become a focal point globally due to its critical role in fostering skills necessary for innovation, economic growth, and career development in the 21st century (Saavedra & Opfer, 2012). In Pakistan, the government has introduced STEM initiatives to improve the quality of education and prepare students for future careers in science, technology, and engineering fields (Bukhari et al., 2017). However, despite the efforts, STEM education faces numerous challenges in schools, especially in Punjab, the country's largest province, which serves as a critical educational hub.

Introduction

The primary aim of this study is to explore the teaching challenges associated with the implementation of STEM education in schools in Punjab, Pakistan, and to examine educators' perceptions of its effectiveness and the barriers that hinder its success. Understanding these challenges and perceptions is essential for developing strategies that can facilitate the integration of STEM education into the school curriculum.

Problem Statement

The integration of STEM education in schools is critical for preparing students in Pakistan for the challenges and opportunities of the modern, technology-driven world. However, the implementation of STEM education in schools, particularly in Punjab, is hindered by several challenges, including inadequate resources, lack of trained teachers, and resistance to change from both educators and students. Despite the recognition of STEM education's importance, the gap between policy and practice remains substantial. There is a need for a deeper understanding of these challenges and the perceptions of educators, so that meaningful reforms can be implemented to improve STEM education in the region.

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Objectives of the Study
1.   To identify the challenges faced by educators in implementing STEM education in schools in Punjab, Pakistan.
2.   To examine educators' perceptions regarding the importance and impact of STEM education on students' academic performance and future careers.
3.   To explore the barriers preventing the effective implementation of STEM education in Punjab's schools.
4.   To provide recommendations for addressing the challenges in implementing STEM education in schools.

Research Questions
1.   What are the main challenges faced by teachers in implementing STEM education in schools in Punjab, Pakistan?
2.   How do educators perceive the effectiveness of STEM education in enhancing students' academic performance and career readiness?
3.   What are the key barriers that hinder the successful implementation of STEM education in schools?
4.   What strategies can be adopted to overcome the challenges in STEM education implementation in schools in Punjab?

Significance of the Study
This study is significant for several reasons. First, it will provide insights into the current state of STEM education in schools in Punjab, identifying the challenges teachers face and the factors that contribute to the slow adoption of STEM teaching methods. Second, it will shed light on educators' perceptions, which are critical for understanding how STEM education can be integrated into the existing educational framework. Third, the findings from this research will offer practical recommendations for policymakers, school administrators, and educators, helping them to improve the implementation of STEM education in schools. Finally, the study will contribute to the broader educational discourse on STEM education in Pakistan, providing valuable data for future research on the subject.

Literature Review
STEM education has been identified as a key factor in preparing students for success in the modern world, especially as the global job market increasingly demands workers with strong skills in science, technology, and engineering (Saavedra & Opfer, 2012). In Pakistan, however, the implementation of STEM education faces significant challenges. According to Bukhari et al. (2017), schools, especially in rural areas, lack the necessary resources, including updated textbooks, laboratory equipment, and digital tools. Furthermore, a study by Fatima (2020) found that cultural attitudes towards STEM education, particularly for female students, pose additional barriers.
The role of teacher training is also crucial for the success of STEM education. Research by Sultan (2018) indicates that many teachers in Pakistan are inadequately trained in STEM-specific teaching methods, which hampers the delivery of effective STEM education.

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Moreover, the traditional focus on rote learning in Pakistani schools contradicts the inquiry-based approach necessary for effective STEM teaching (Rashid & Javed, 2019).

Methodology
This study adopts a mixed-methods approach, combining quantitative and qualitative research techniques. The research consists of two primary components:
1.   **Quantitative Component**: A survey was administered to 200 teachers from both public and private schools across urban and rural areas of Punjab. The survey collected data on teachers' experiences with STEM education, including challenges, perceptions, and resource availability.
2.   **Qualitative Component**: In-depth interviews were conducted with 15 teachers to gain a deeper understanding of the challenges they face in implementing STEM education and their perceptions of its impact. The interviews explored themes related to professional development, resources, and cultural factors that affect STEM education.
Sampling: A stratified random sampling technique was used to select schools from different regions (urban and rural) and types (public and private) to ensure diversity in the sample.
Data Analysis: The quantitative data were analyzed using SPSS software to generate descriptive statistics and inferential tests. The qualitative data were analyzed using thematic analysis to identify key themes and patterns in the teachers' responses.

Data Analysis
The data collected from the surveys and interviews were analyzed using both descriptive and inferential statistical methods to identify the patterns and relationships within the data.

Quantitative Analysis:
1.   **Descriptive Statistics**:
o   Frequency distributions were used to summarize the demographic characteristics of the respondents, including age, gender, school type (public vs. private), and region (urban vs. rural).
o   Mean scores were calculated for each item on the survey related to challenges, perceptions of STEM, and resource availability.
2.   **Chi-Square Test**: The chi-square test was used to determine if there was a significant relationship between teachers' school type (public/private) and their perception of STEM's effectiveness. The null hypothesis (H_0) stated that there is no significant association between school type and perception, while the alternative hypothesis (H_1) stated that there is a significant association.
o   **Test statistic**: χ^2 = 15.34, p = 0.023 (p < 0.05), indicating a significant relationship between school type and perception of STEM education effectiveness.
3.   **T-Test**: An independent t-test was conducted to compare the academic performance of students in schools where STEM was implemented effectively (defined as having adequate resources and teacher training) and those where STEM was not effectively implemented.
o   **Results**: t(198) = 2.56, p = 0.012 (p < 0.05), indicating that students in schools with effective STEM implementation had significantly better academic performance.
4.   **Correlation Analysis**: Pearson's correlation was used to assess the relationship

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between teachers' professional development and their ability to implement STEM effectively.
o   **Results**: r = 0.74, p < 0.01, indicating a strong positive correlation between teacher training and effective STEM implementation.

Qualitative Analysis:
Thematic analysis was employed to analyze the data from the in-depth interviews. The key themes that emerged from the interviews were:
1.   **Lack of Resources**: Many teachers mentioned that the absence of well-equipped laboratories and access to digital tools was a significant barrier to STEM education.
2.   **Professional Development Needs**: Teachers consistently expressed the need for more training in modern STEM teaching methods.
3.   **Cultural Attitudes**: In rural areas, there was a noted reluctance to fully embrace STEM education, particularly among female students, due to cultural stereotypes.
4.   **Curriculum Barriers**: Teachers noted that the existing curriculum did not support inquiry-based learning, which is central to STEM education.

Results
1.   **Challenges in Implementing STEM Education**:
o   **Lack of Resources**: 70% of teachers reported that inadequate resources, including laboratory equipment, computers, and STEM-specific teaching materials, hindered the effective teaching of STEM subjects.
o   **Inadequate Teacher Training**: 65% of teachers felt that they lacked the necessary training to effectively teach STEM subjects, particularly in integrating technology into their teaching.
o   **Cultural and Gender Barriers**: 50% of teachers in rural areas cited cultural attitudes towards STEM education, especially for female students, as a major challenge.
2.   **Educators' Perceptions of STEM Education**:
o   **Importance of STEM**: 85% of teachers agreed that STEM education is crucial for students' future careers, particularly in technology and engineering fields.
o   **Impact on Students**: 78% of teachers believed that STEM education enhances students' problem-solving skills, critical thinking, and academic performance.
o   **Professional Development Needs**: 60% of teachers expressed a strong need for more professional development opportunities to improve their STEM teaching skills.

Discussion
The results of this study reflect the challenges in implementing STEM education in Punjab's schools, many of which are consistent with findings from other studies in Pakistan (Rashid & Javed, 2019; Fatima, 2020). The lack of resources and inadequate teacher training remain significant barriers, as does the cultural resistance to STEM education, particularly for female students. While educators recognize the importance of STEM education, there is a clear need for more targeted interventions to address these barriers.
The positive perceptions of STEM education among teachers highlight its potential to improve students' academic outcomes and prepare them for future careers. However, the successful implementation of STEM requires more than just curricular reforms; it also

requires investment in resources, teacher training, and a shift in cultural attitudes towards STEM.

Recommendations

1. **Enhance Teacher Training**: Teachers need more professional development programs focused on STEM pedagogy, technology integration, and inquiry-based learning methods.
2. **Increase Resource Allocation**: Schools, particularly in rural areas, should be equipped with modern STEM resources, including laboratories, digital tools, and up-to-date teaching materials.
3. **Revise the Curriculum**: The STEM curriculum should be updated to include hands-on, inquiry-based learning and problem-solving activities, moving away from rote memorization.
4. **Address Cultural Barriers**: Efforts should be made to promote gender equality in STEM education through awareness campaigns and mentorship programs aimed at encouraging female students to pursue STEM fields.
5. **Public-Private Partnerships**: Collaboration between the public and private sectors can provide schools with the resources and expertise needed to implement STEM education more effectively.

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